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Bearing structure

The present invention concerns a bearing structure having the features of the classifying portion of claim 1. The invention further concerns a process for the production of a shaped body, in particular a rotor blade, of a fibre composite structure, comprising the following steps:

- producing shells forming the outer contour of the shaped body,
- producing bearing structures of fibre strands of predetermined length which are impregnated with a hardening composite material, and
- transporting the bearing structure into the shells.

The invention further concerns a rotor blade produced in accordance with that process and a wind power installation having such a rotor blade.

Such a process has long been known in particular in the field of wind power and makes it possible to produce rotor blades with a dependable join between the bearing structure and the shells forming the outer contour of the rotor blade as the same materials are used in each case.

In that respect half-shell portions for example of fibre composite material such as glass fibre and epoxy resin are produced, and these determine the external shape of the rotor blade. As such rotor blades perfectly well reach lengths of more than 50 metres, loads occur, which must be absorbed and dissipated. That is effected by way of the bearing structure provided in the rotor blade.

Such a known bearing structure comprises so-called roving webs. These involve strands of fibre material such as carbon fibre or, preferably because of the low cost, glass fibre. Those strands extend in part continuously over the entire length of the bearing structure or the rotor blade. The number of webs also increases with increasing proximity to the rotor blade root in order to absorb and dissipate the higher loads by virtue of a greater blade thickness and blade depth.

In order to achieve an adequate load-bearing capability, a suitably large number of those roving webs is used. They are impregnated with a polymer such as for example epoxy resin before being fitted into the prefabricated rotor blade shell. It will be appreciated that the impregnation operation can be effected equally by feeding the polymer from the outside and also by an injection process. The impregnated roving webs are then fitted into the shell of the rotor blade at the intended positions. As the rotor blade is made from the same material, there is an excellent join between the shell and the roving webs.

As those roving webs are laid 'wet' in the shell however deformations can easily occur in that procedure as those wet webs are not flexurally stiff. Such deformations are also referred to as 'undulations' and after hardening result in a spring effect at that location. That adversely affects the stiffness of the bearing structure or the rotor blade.

In addition hardening of the polymer is an exothermic process in which heat is correspondingly given off to the exterior. In the case of bearing structures comprising a large number of roving webs, a correspondingly large amount of epoxy resin is also required in order to produce an adequate join. The exothermic reaction is correspondingly intensive and the amount of heat given off is correspondingly high.

As general state of the art attention is to be directed to DE 44 23 115 A1 and DE-AS No 1 264 266.

Therefore the object of the present invention is to develop a process of the kind set forth in the opening part of this specification such that the exothermic reaction is limited and the risk of undulations is reduced.

According to the invention that object is attained by a bearing structure having the features of claim 1 and a process for the production of a shaped body having the features of claim 3. Advantageous developments are set forth in the appendant claims.

In accordance with the invention therefore it is proposed that prefabricated, flexurally stiff components are integrated into a bearing structure. In that respect the invention is based on the realisation that prefabricated components, even if they are again made up of a fibre

composite system such as carbon fibre or glass fibre webs and a polymer, are already hardened and thus permit a corresponding reduction in the material which is to be processed wet, and thus lead to a reduced exothermic reaction. In addition those prefabricated components stiffen the wet constituents and thus contribute to reducing the undulations, that is to say the unwanted deformations of the fibre strands.

It will be appreciated that those prefabricated components can also comprise any other suitable material. In that respect a further advantage of using prefabricated components is that they can be separately produced and subjected to quality control.

The quality of those components, which is ensured in that way, and the low level of exothermy, also affords an overall improvement in the quality of the bearing structures.

Particularly preferably those prefabricated components are of a length which substantially corresponds to the length of the bearing structure to be constructed. That implements a continuous structure which also permits a continuous flow of force.

Advantageous embodiments of the invention are set forth in the appendant claims.

The invention is described in greater detail hereinafter with reference to the Figures in which:

Figure 1 shows a simplified view in cross-section through a rotor blade,

Figure 2 shows a simplified internal view of a rotor blade shell,

Figure 3 shows a simplified view of a known bearing structure,

Figure 4 shows a simplified view of a bearing structure according to the invention,

Figure 5 shows a view on an enlarged scale in cross-section of a prefabricated component according to the invention, and

Figure 6 shows an alternative embodiment of a bearing structure according to the invention.

Referring to Figure 1 shown therein in simplified form in cross-section is a rotor blade 10 for a wind power installation. That rotor blade

includes an upper shell 11 and a lower shell 12. Provided in those shells 11 and 12 are bearing structures 14, 16 which absorb and dissipate the loads acting on the rotor blade 10.

Figure 2 is a simplified inside view of such a shell 11, 12. Provided at a predetermined position of a shell 11, 12 is a bearing structure 14, 16 which extends over the entire length of the shell 11, 12 and thus over the entire length of the rotor blade produced therefrom.

Figure 3 once again shows in simplified form the structure of a known bearing structure 14, 16. That bearing structure is formed from fibre bundles 20, so-called roving webs, which are enclosed by an epoxy resin 22. It will be appreciated that that fibre material can be a carbon fibre, glass fibre or any other suitable fibre. It is also to be noted that the round bundling of the roving webs 20, which is shown in this Figure, only serves for illustration purposes. In reality the bundles can be of any desired shape.

It can already be clearly seen in this Figure that such a (wet) arrangement of webs 20 and epoxy resin 22 is always subject to the risk of deformation, so-called undulations, precisely with the considerable lengths involved.

Figure 4 shows an embodiment according to the invention of a bearing structure 14, 16. This bearing structure 14, 16 also has roving webs 20 which are embedded in the epoxy resin 22. It will be noted however that it is possible to clearly see here the prefabricated components 24 which are inserted into the bearing structure 14, 16 according to the invention. They can extend over the entire length and form layers which are capable of bearing and supporting the roving webs 20.

As the prefabricated components 24 already exhibit their final flexural stiffness, they form a support structure which prevents deformation of the roving webs 20. Accordingly the bearing structures 14, 16 constructed therewith are of high quality.

Figure 5 shows a cross-sectional view on an enlarged scale of an embodiment of a prefabricated component 24. As can be seen from this Figure this prefabricated component 24 can again be made up of roving webs 20 and epoxy resin 22. It will be noted however that it is already in

the finished hardened condition at the moment of fitment into the bearing structure 14, 16, but by virtue of the selection of material involved it results in an intimate join in the bearing structure 14, 16 according to the invention and thus ensures a satisfactory flow of force.

Figure 6 shows a second embodiment of a bearing structure 14, 16 according to the invention. In this case, the arrangement of the roving webs 20 between the prefabricated components 24 is not illustrated in this Figure, for simplification purposes. It can also be seen from this Figure that the prefabricated components 24 are here not arranged in individual columns one below the other but are arranged in displaced row-wise relationship with each other.

This arrangement results in even better strength for the bearing structure 14, 16 according to the invention.

The rotor blade according to the invention is distinguished by a considerably better level of stability by virtue of the use of the prefabricated components. In this case tensile forces can be absorbed, which are markedly higher than in the case of previous rotor blades.

A configuration of the invention has been described hereinbefore by means of a rotor blade, as a possible option for a shaped body. Instead of a rotor blade the invention can also be very advantageously used for aircraft airfoils, ships and other shaped bodies, in respect of which, with a high level of strength, a high dynamic load-bearing capacity is nonetheless required.